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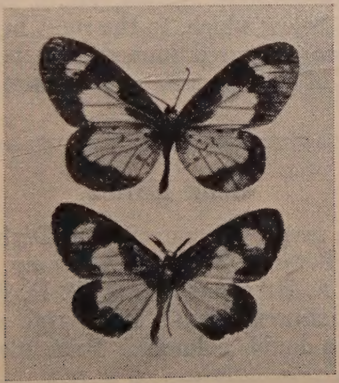
RESEMBLANCE OF A GEOMETRID MOTH *AMNEMOPSYCHE* (*AGIRPA*) *WARDI* E. M. SHARPE TO THE BUTTERFLY *ACRAEA ACERATA TENELLA* ROG. IN THE CONGO

By Professor G. D. Hale Carpenter, F.R.E.S.

I am indebted to the Keeper of Entomology, British Museum (Natural History) for permission to photograph the specimens which were found in a collection of butterflies from the Belgian Congo sent to the museum by Mr. F. G. Jackson, bearing data as follows, " Belgian Congo, Nyanza, 31.v.1926 " in the case of the *Acraea*, and " Belgian Congo, 1926 " in the case of the Geometrid. The two specimens were noted by Mr. T. G. Howarth, of the Department of Entomology, when the collection came in from the setting room, and he kindly called my attention to the extraordinary likeness which seems to have deceived the collector, as there were no notes on the moth to show that its real nature had been appreciated. The photograph (by Imperial Forestry Institute, Oxford), fig. 1, shows the extraordinary correspondence in pattern, and the pale cream of the moth is very close to the pale buff of the butterfly. On the undersurface the resemblance is less perfect, as the moth lacks the characteristic Acraeine spotting. The moth was identified by Mr. L. B. Prout, who kindly referred me to a record of its occurrence in the Belgian Congo by Aurivillius (1925, *Ergebn. deuts. 2te Zentral Afr. Exp.* **1** (18) : 1337), but that author made no mention of its deceptive appearance.



The resemblance is probably synaposematic (Müllerian) rather than pseudaposematic (Batesian), for day-flying Geometridae in Africa are frequently copied by Lycaenid (and other) butterflies.

NOTE ON PROF. CARPENTER'S PAPER

By Dr. B. M. Hobby, F.R.E.S.

Butler (1869, *Proc. zool. Soc. Lond.*, **1869** : 43–45) erected the genus *Amnemopsyche* with *Papilio charmione* F. (1793, *Ent. Syst.*, **3** (1) : 205, 641) as genotype, pointing out that this species was really a moth and stating that " The supposition that *charmione* was a Rhopalocerous insect seems to have arisen from the fact that it is represented as such by Donovan." Donovan's illustration (1834, *Nat. Repos.*, **5** : pl. 171) is an excellent copy of the figure in Jones' *Icones*, **2** : pl. 1, fig. 2, save in two respects, *viz.*, the submarginal spots are too intensely yellow and the antennae are boldly depicted in black whereas in Jones' original painting they are lightly indicated in grey. Both Jones and Donovan drew the antennae as those of a butterfly, but Jones' pictures of other species have the antennae well defined and his reluctance to portray those of *P. charmione* in a like manner suggests that they were missing from the specimen illustrated and is yet another example of this brilliant artist's careful attention to detail.

Fabricius gave " Habitat in Insula Johanna " as the type locality for *P. charmione*, but Donovan (*loc. cit.*) states that " We . . . perceive in our copy of the Entomologia Systematica, that this habitat is erased, a correction made by ourselves many years ago upon the authority of Mr. Jones himself. Referring from thence to the manuscripts of Mr. Drury, now in our possession, we find nothing satisfactory on this subject." These manuscripts are now in the Hope Library, Oxford University Museum. Westwood's copy of the same work, also in the Hope Library, contains the following manuscript note which has been verified with the *Icones* :—" The mistake of Fabricius as to the habitat of this insect arose thus :—In Jones' *Icones*, Vol. 2, Helic., pl. 1, the upper fig. represents *Hestia lynceus* below which, to the right hand, is written its ' Habitat,' Johanna. *charmione* is figured immediately below from the Cabinet of ' Drury,' but at the end of the short Fabrician description, which is quoted, is added—' habitat——.' "

Book Notice.

A dictionary of scientific terms. Pronunciation, Derivation, and Definition of terms in Biology, Botany, Zoology, Anatomy, Cytology, Embryology, Physiology. By I. F. Henderson and W. D. Henderson. 3rd edition revised by J. H. Kenneth. 8vo. Edinburgh and London. 1939. pp. xii + 383 [printed in double column]. Price 16*s*.

This is the 3rd edition of the well-known dictionary of which the 1st appeared in 1920 and the 2nd in 1929.

Some terms have been added, mainly words of recent appearance, and some of the older terms have acquired additional meaning since the publication of the 2nd edition.

A short list of abbreviations commonly occurring in biological literature has been added.

A rough estimate of the number of terms included gives the total of nearly 11,000.

For each term included the following information is given : pronunciation, derivation, definition and application.

BOOK NOTICE.

Psyche und Leistung der Tiere. Von W. FISCHEL. 8vo. Berlin (W. de Gruyter). 1938. pp. vi + 290, 105 figs. RMk. 15.00.

This book gives a scientific exposition of the psychology of animals, including insects. The psychic factors have been examined in detail, more so than the animals themselves. Attention is given to all problems, and their difficulties explained, so that the present position of the study of animal psychology is stated in detail. Particular regard is necessarily paid to experiments made by the author of the book.

Of necessity, the main part of the book is more of interest to students of the so-called higher animals, and insects occupy a relatively unimportant place. Some interesting experiments with Centipedes are related.

BOOK NOTICE.

Ergebnisse der Insektenbiologie Band 1. Die Brutfürsorge- und Brutpflegeinstinkte der Käfer. Von H. v. LENGERKEN. 8vo. Leipzig (Akademische Verlagsgesellschaft M.B.H.). 1939. RMk. 19.60 (bound). pp. viii + 285, 188 figs.

This volume is the first of the series issued under the editorship of the author of the volume.

The work represents an attempt to summarise existing knowledge on the subject of the instinct in beetles to provide and care for their brood. Hitherto the published information on this subject has been widely scattered in a variety of periodicals and books written in a number of languages. Prof. Lengerken has brought all the information available to him into the compass of a small volume. The work deals with maternal instincts in relation to protection of the eggs, the provision of food for newly hatched larvae, the several forms of nursing adopted by the parent, both direct and indirect, and parasitism in brood after the manner of the cuckoo.

A quite short bibliography and an index complete the book.

BOOK NOTICE.

Catalogus Coleopterorum Japonicorum. Pars 1 BUPRESTIDAE 1936 pp. 26 + 4 + 3; Pars 2 LUCANIDAE 1936 pp. 11 + 3; Pars 3 PASSALIDAE 1936 pp. 2 + 1; Pars 4 PAUSSIDAE 1937 pp. 2; Pars 5 SCARABAEIDAE 1939 pp. 94; Auct. Y. MIWA et M. CHÛJÔ.

These five parts are the first to be published of the projected catalogue of the Coleoptera of Japan. It is estimated that 103 Families require cataloguing and in the 6 parts so far published (Pars 6 has already been noticed) 35 are completed.

The Catalogue lists under genera the species so far recorded from Japan. Where varieties and such lower categories have been named they are included, but only the species are numbered.

The reference to the original description and the distribution, including that outside Japan, is given.

Some synonymy is included and the catalogue includes a reference to the new names proposed in Japanese publications in recent years.

SOME MINUTE DIPTERA ASSOCIATED WITH MILLIPEDES IN TANGANYIKA

By E. Burtt, F.R.E.S.

It was with great interest that I read the article entitled, "A new species of Phoridae (Diptera) associated with Millipedes, from the Yemen," by the Rev. Fr. H. Schmitz. The article was communicated to the Society by Dr. Hugh Scott, whilst the Phorid flies concerned were stated to have been noticed initially by Mr. E. B. Britton (*Proc. R. ent. Soc. Lond.* (B) **8** : 43). During a period spent recently in Tanganyika, I made some notes relating to certain of the indigenous millipedes. These notes were published in the *Tanganyika Notes and Records* No. 6 in December 1938, p. 92. One paragraph concerns the association which was observed between a millipede and some minute Diptera (possibly Phoridae). Hence it may bear on the same theme as that dealt with by the Rev. Schmitz, and I am taking this opportunity of bringing the observation to the notice of the Society. The relevant passage reads as follows: "Late in December 1935 I was waiting near the edge of a road which leads up the Rift Escarpment about thirty miles south-east of Singida. As I was sitting there, a black millipede of the ... *Julus* type, about six inches in length, emerged from the scanty herbage fringing the road edge. For a millipede it was doing good speed. I watched it idly. Suddenly my curiosity and interest were aroused by ... seeing the millipede sprawl over on its back with its legs waving in the air and beat rapidly from side to side with the front and hind ends of its body. It was then that I noticed that there were two or three small flies in attendance on it. Having no net with me, I was unable to secure a specimen for examination. The millipede, having freed itself of the flies' attentions for a moment by its contortions, pursued its course across the road. Similar antics were performed and repeated two or three times before it gained the far side and the entire assemblage was lost to view. This observation is regrettably incomplete, but does suggest the possibility of a parasitic relationship."

Book Notice.

Animal Ecology. By A. S. Pearse. 2nd edition. 8vo. London (McGraw-Hill Publishing Co.). 1939. pp. xii + 642. Price 30*s*.

The first edition of this work appeared in 1926, since when so much progress has been made in Ecology that a complete revision has been necessary. The new arrangement is thought more logical, and new chapters and 132 illustrations have been added.

The work now contains 17 chapters on Environments, Animals, Ecological Factors, Evolution Chorology Succession and Climaxes, Rhythms, Communities Competition Populations and Classification of Communities, Ocean, Fresh-water, Terrestrial Habitats, Relation of Animals to Plants, Intraspecific Relations, Interspecific Relations, Economic Ecology, Teaching of Ecology, Ecological Methods, and Problems of Ecology. A short title bibliography extending to 65 pages and an index complete the book.

The volume forms one of the well-known McGraw-Hill publications in the Zoological Sciences and is uniform in appearance with other volumes in that series.

FRIGHTENING ATTITUDES AND FLORAL SIMULATION IN PRAYING MANTIDS

By G. C. Varley, F.R.E.S.

In this paper a new description of the frightening attitude of *Stagmomantis* sp. is given, and the various other cases of frightening attitudes in the Mantidae are reviewed, and considered in relation to the cases of floral simulation which have been described in the group.

A large pale brown mantis, *Stagmomantis* sp., was found in the neighbourhood of Riverside, California, and kept in captivity. When it was irritated with a finger it suddenly adopted a frightening attitude, which, as far as I am aware, has not been described before. This attitude is illustrated in fig. 1. The head faces the threat and the antennae extend forward parallel to each other. The fore legs are spread out on either side of the head, instead of being folded beneath the head in the praying position. The body is twisted sideways, and the wings and tegmina are raised, with their upper surfaces in contact. One tegmen is held so that its fore margin comes close up to the prothorax, while the other fills the space between it and the hind-wings. The abdomen is curled upwards so that it follows the curve of the hind border of the hind-wings. The result of this change in posture is to expose to view the dull purple hind-wings, which are normally covered by the tegmina, and to increase greatly the apparent size of the insect.

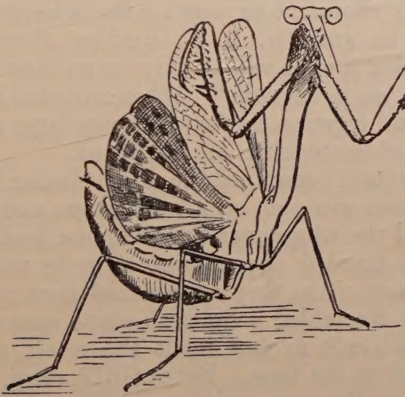


Fig. 1.—*Stagmomantis* sp. in the frightening attitude. Drawn from a pinned specimen.

The first account of the frightening attitude of a mantis is that of Goureau (1841), who described how *Mantis religiosa* Linn. reacts to a threatening hand. The insect raises its head and prothorax, and holds the fore legs well separated, so that the prominent eye-like marks on the fore coxae are displayed. The tegmina are spread out horizontally, and the hind-wings raised. In addition, the insect stridulates, making a rustling noise by rubbing the abdomen up and down between the hind-wings (Stäger, 1928). This behaviour is also described and illustrated by Fabre (1879, chap. xviii), who observed the reactions of the species in cages. This account is quoted by Coupin (1899). The frightening attitude was adopted towards a threatening finger, or towards large insects such as locusts, when they approached. These apparently paid no attention to the peculiar behaviour of the mantis, and might eventually be attacked and eaten. Smaller prey were seized and eaten without this preliminary posturing.

Roonwal (1938) described and illustrated the curious behaviour of the primitive mantid *Eremiaphila braueri* Kr., which when pursued first ran away, and then suddenly turned and reared up " like a performing bear " and spread out its wings, so as to expose the dark marks on the underside of the tegmina, and the purple hind-wings.

Shelford (1903) gave a very detailed account of the behaviour of *Hestiasula sarawaka* (West.) (illustrated by Chopard, 1938, fig. 371, p. 366). This species resembles a piece of wood, but on the approach of large prey or when irritated it adopts a frightening attitude. It displays prominently the crimson inner faces of the fore coxae, and the flat expanded yellow and black fore femora. It also raises the mottled tegmina and the hind-wings, and rustles them. It vibrates the antennae, and snaps the fore tibiae with clock-like regularity on the femora, and sways from side to side. As Hingston (1933) pointed out, this display, with its curious posture, menacing movements, sounds, and bright colours, combines in one all the ingredients of frightening or defensive displays. Shelford mentioned various examples of similar but less complex displays in other members of the HYMENOPODINAE, such as *Deroplatys shelfordi* Kirb., *Gryllacris*, and *Theopropus*, which raise the tegmina and wings, spread the fore legs, and sway when irritated. *Deroplatys desiccata* Westw. displays the flattened coloured fore legs, but not the white marks under the tegmina; *Tenodera superstitiosa* (Fabr.), a Mantine with plain fore legs, does not display at all.

Dr. H. B. Cott kindly allows me to mention the behaviour of *Pseudocreobotra wahlbergi* Stål, which he and Mr. L. C. Bushby observed in Africa. An illustrated account of this species will shortly be published by Dr. Cott in his book " Adaptive coloration in animals." When irritated it puts its head down and spreads its wings and tegmina, so that the very large and conspicuous eye-spots on the upperside of the tegmina are displayed.

Krauss and Vosseler (1897) described the rather similar behaviour in *Empusa egena* Charp. A specimen was seen on a small stone and when approached it spread the tegmina and the wings over the abdomen, and moved them to and fro. As the observers receded the normal attitude was resumed, but the performance started again when they approached once more. These authors remark that the insect resembled a greenish-white anemone swinging in the wind; however, the attitude in fact made the insect conspicuous as there happened to be no wind at the time. Fabre (1879, chap. xxii) found that the nymphs of this species of *Empusa* swayed to and fro when approached, but he made no mention of any such behaviour in the adults, which he kept under observation in cages. The facts available suggest that here again is an example of a frightening attitude, and they lend no support to the contention of Sharp (1899) that *Empusa egena* is to be classed as a floral simulator. He was perhaps influenced by the fact that the classic example of a floral simulator was another Empusine, *Gongylus gongylodes* (Linn.), and that the related species *Idolum diabolicum* Sauss. also seemed to come in this category. Sharp described and illustrated *Idolum diabolicum*, the upper surface of which is green and cryptically coloured, while the underside of the prothorax and especially the inner surfaces of the flat expanded fore coxae are brightly coloured. Sharp's correspondent, Muir, saw *Idolum* in the field with its fore legs widely spread, so that the colours were exhibited, and was impressed by its flower-like appearance. He states that flies were attracted by bits of coloured paper, and gives the impression that *Idolum* waits for flies with its fore legs outspread. However, it is difficult to see how flies could be grasped by the fore legs when in this attitude. A very different interpretation of the attitude is presented by Carpenter (1921), who made careful field observations on the reactions of a tame monkey to the different insects it encountered. The first *Idolum* which the monkey found suddenly reared itself up into a position very like that illustrated by Sharp (1899), thus displaying its brilliant colours. Carpenter states that the mantis did not appear at all flower-like to him, and the monkey was evidently surprised, and backed away without attacking it. Another *Idolum*, which was close to both the monkey and to the observer when it was disturbed, faced first one and then the other as it displayed, and besides this it stridulated by rubbing one hind leg against a file on the edge of the tegmen, and produced a sound " like a small sneeze with a click in it." After its first encounter with *Idolum* the monkey was no longer put off by the display, and captured and ate a number of them with relish. Clearly the frightening attitude is just a bluff in this case, and does not advertise distasteful properties.

It appears from the papers of Sharp and Carpenter that the peculiar attitude of *Idolum* may not only serve the function of attracting prey, but also play a part in the frightening display. Though there is no evidence that insects are attracted to *Empusa* when it is in its " flower-like " attitude, Williams (1904) showed that the Empusine *Gongylus gongylodes* attracts insects by its colour, and also has a frightening display in which the colour is exhibited. Anderson (1877), who also studied this species, found that the nymph hangs upside down amongst flowers with the flat lavender-coloured underside of the prothorax turned towards the light, and the fore legs in the normal praying position. According to Williams, small insects which investigate the patch of colour are captured and eaten; but when some large beetle, butterfly, or hymenopteron investigates the floral expansion, or when the mantid is threatened with a finger, it sways from side to side, and displays the bright purple and white-spotted inner surfaces of the fore coxae and the reddish-brown fore femora, while the abdomen swells up and exposes colour bands which are not otherwise visible. This observation is partly confirmed by Anderson, who remarks that in this attitude the mantid bears some resemblance to a papilionaceous flower. In adults of *Gongylus* (Willey, 1918) the swaying causes the hind legs to rub on the edges of the tegmina, and produces a loud rasping noise. According to Wood-Mason (1878a) this stridulatory file is present in all the EMPUSINAE and in *Hierodula*, a Mantine. There is a series of sharp teeth on the underside of the front edge of each tegmen. When the wings are folded in the resting position, this file is close to a ridge on the hind coxae in *Idolum* and *Gongylus*, which may act as the plectrum. The file cannot meet the hind femur unless the tegmina are raised, and the under surface twisted outwards. This is just the posture adopted by *Empusa*, in its frightening attitude, and it seems probable from the anatomy of the insect that when *Empusa* sways, the hind femora will rub on the file and produce a sound.

It seems likely that the prothoracic and the femoral expansions in *Gongylus* and *Idolum* were evolved in relation to the procryptic appearance of the insects in their resting attitudes, in which their green colour and flattened shape tend to make them inconspicuous amongst foliage; and it is tempting to believe, with Shelford (1903) and Chopard (1938), that the brightly coloured inner surfaces of the coxae and femora of the fore legs, and the colours of the under surfaces of the prothorax which are exhibited in the frightening display and probably evolved with it, have secondarily come to be utilised by *Gongylus* and probably also by *Idolum* to attract prey.

Finally there is the very interesting case of *Hymenopus bicornis* (Stoll). Meade-Waldo (1910) observed that in captivity the fully grown nymph adopted a very peculiar attitude when irritated. The head and the prothorax were raised, and the middle and hind legs were turned into a very curious position, so that the flat expansions on their femora were displayed, and the abdomen was curved up over the back. The whole body of the nymph was a translucent white or pink, except for a green band across the thorax, and rows of dashes on the upper surface of the abdomen. Meade-Waldo noticed that the insect had a generalised resemblance to the large flower of an orchid; but no local species was of this appearance. This frightening attitude of *Hymenopus bicornis* is very similar, if not identical, to the attitude shown in the photographs of Annandale (1900) and the drawing in Poulton's book (1890 : 74) in which the nymph is shown amongst the flowers of *Melastoma*. In this situation the mantis is very difficult to see, because the green thoracic band breaks up the outline and makes it resemble two separate flowers. Annandale states that flies settled on the flowers and on the body of the mantis indiscriminately. Although he did not see any fly captured which alighted on the mantis itself, one fly which settled just in front was captured and eaten. Wallace (1877, 1889) evidently saw a nymph of this species amongst green foliage, where it was very conspicuous. He found that it fed particularly on butterflies which were attracted to it by its flower-like appearance. There is no detailed account of the behaviour of the adult *Hymenopus*, but Shelford (1902) found that the first instar nymph bore a striking resemblance to the nymph of a distasteful Reduviid bug.

Hymenopus seems to use a similar posture both in the frightening display and while waiting for prey amongst flowers or foliage. While amongst flowers its appearance may be regarded as procryptic, just as in the case of the British Thomisid spider *Misumena vatia* Clerck whose body resembles in colour and appearance a petal of the flower (buttercup, or bramble) in which it waits for prey. On the other hand, when *Hymenopus* is amongst foliage, according to Wallace (1877, 1889), it is investigated by flower-seeking insects. This does not necessarily imply close resemblance to any particular flower. Knoll (1921–6) showed that the fly *Bombylius* and the moth *Macroglossa* were attracted to pieces of coloured paper which were not at all flower-like in shape. According to Kühn and Ilse (1925) and Ilse (1928) the same is true of the butterflies *Vanessa* and *Pieris*; and Wasmann (1926) showed that the beetle *Meligethes* was spontaneously attracted to yellow objects. The closeness of the floral resemblance of *Hymenopus* is therefore likely to be of significance only in protecting the insect from possible predators. This case differs from that of *Gongylus* in that the floral resemblance is probably procryptic in origin, and is not dependent on colours which seem to have evolved in association with a frightening display.

In the literature, then, it may be seen that attitudes and displays towards a threat have been recorded in many species of mantids. They belong to the subfamilies EREMIAPHILINAE (*Eremiaphila*), MANTINAE (*Mantis, Stagmomantis*), HYMENOPODINAE (*Hymenopus, Hestiasula, Deroplatys, Theopropus, Pseudocreobotra*) and EMPUSINAE (*Empusa, Gongylus, Idolum*). Probably such behaviour is widespread in the group, though it is so far known from a very small proportion of the species.

None of these cases considered alone would be very instructive, but owing to the variety of the postures characteristic of each species it is possible to draw some general conclusions. Firstly, the attitude adopted seems to be fairly closely correlated with the distinctive colours and markings of the mantid, and tends to expose them to view, even though in the normal resting pose they are not to be seen at all. This correlation between special structures and marks and the type of display is a very general phenomenon, not only in aggressive or defensive displays, but in sexual displays, as indicated by Hingston (1933) and Richards (1927). Secondly, in the majority of the cases mentioned here the mantid increases its apparent size by spreading its wings, but makes no attempt to take to flight.

In walking a mantid uses all three pairs of limbs, but in the special "praying" attitude the fore legs are tucked up under the head. According to Shelford (1903), when a mantid is about to strike out at its prey the fore coxae are slightly rotated outwards, and the insect may sway a little from side to side. (May not this swaying be analogous to the bobbing movements of certain lizards, e.g. *Phrynosoma*, and enable the animal to judge the distance of its prey by parallax?) If the prospective prey is larger, Shelford states that the fore legs are held wide apart, and so display any colours or markings on the inner surface of the coxae or femora (*Hestiasula*, *Mantis*, *Gongylus*). If a very large insect approaches, the mantis may also spread the wings (*Hestiasula*, *Mantis*) or stridulate (*Hestiasula*, *Mantis*, *Gongylus*). An exactly similar reaction is obtained towards a threat, and these reactions to small prey, and to large prey or a threat can be interpreted as a graded response to increasing degrees of stimulation.

Mantids would be very suitable material for experiments on behaviour, and nearly a hundred years ago, in 1841, Goureau gave an account of an experiment on *Mantis religiosa*, which adopted the frightening attitude when threatened. By threatening it with a finger and whistling at the same time he rapidly established what is now known as a conditioned reflex, and the mantis would react to the whistle alone. It is obvious from the fragmentary nature of the observations on mantid behaviour in the field that a great deal of careful work needs to be done before the true significance of these frightening attitudes can be ascertained. It is hoped that this review, by bringing together the information already available, will stimulate those who regularly come in contact with these insects to study them in detail and learn what function the displays have in the life of the animal.

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UNUSUAL METHODS OF STRIDULATION IN A CICADA (*CLIDOPHLEPS DISTANTI* (VAN D.)) AND A GRASSHOPPER (*OEDALEONOTUS FUSCIPES* SCUD.) IN CALIFORNIA

By G. C. Varley, F.R.E.S.

In the Cicadas and Grasshoppers sound production is usually confined to the male, which attracts the females of the species by its song. The efficiency of such a mechanism which aids the meeting of the sexes will depend on the ability of the females to recognise the song of the male of the species from all the other sounds in the environment. It is therefore not surprising that the songs of closely allied species and even races of the same species may show considerable diversity, so that human ears can usually learn to distinguish the songs of all the species living in any one region. Any new mechanism of sound production might therefore be advantageous to a species in giving it a song more readily distinguishable from that of its allies. It is the object of this paper to describe two remarkable cases of stridulation in which the organs concerned are quite different from those used by related genera.

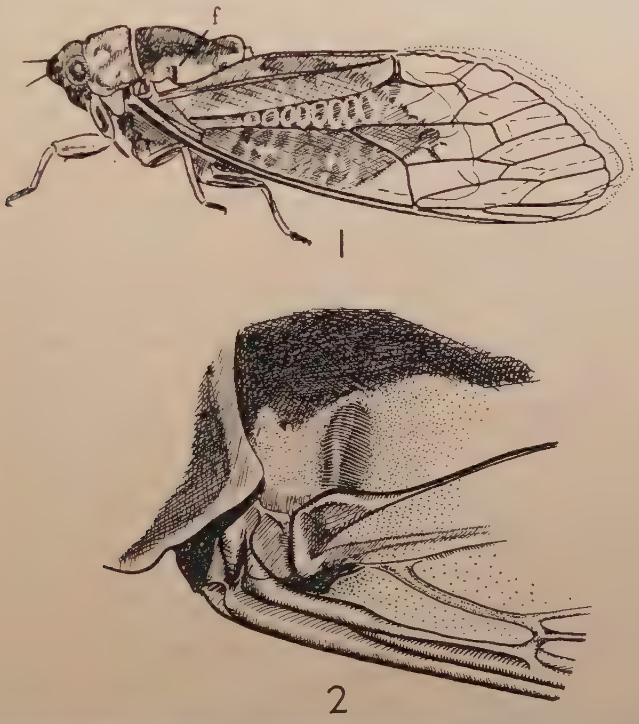

Fig. 1.—*Clidophleps distanti* Van D. showing the stridulatory file (f) on the mesothorax; fig. 2.—The stridulatory file in detail, showing its relation to the wing base when the wings are in the resting attitude.

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The Cicada *Clidophleps distanti* (Van D.)[1] was found commonly near Riverside, California, in the uncultivated region lying between the Citrus Experimental Station and the Box Springs Mountains. Its usual song was a short shrill squeak or chirp produced by the timbals, but besides this song another much louder noise was occasionally made by an entirely different mechanism. This second sound was not heard very often, and only once was I fortunate enough to observe how it was made.

A male of *C. distanti* had been located by listening to its squeaking, and I was watching it from a distance of about six feet. It and the other members of the species in the neighbourhood were emitting occasional short squeaks, and were apparently replying to each other, as an irregular chorus of squeaks would be followed by many seconds of silence. Suddenly a second cicada flew up and alighted close to the first, and at the same moment the first began to flutter its wings rapidly. Coincident with the fluttering a loud, harsh, sizzling, noise was heard which rose to a maximum and quickly faded into a squeak followed by silence as the wings ceased their fluttering. The whole performance only lasted about five seconds. Both cicadas were captured, and they were male and female; whether both joined in making the noise I am not certain. The action was over so rapidly and was so unexpected that it was not possible to take in all the details. However, the apparatus by which this noise is made is equally developed in both sexes, and probably both make the noise together by this fluttering movement.

The sound is produced by the file and scraper method which is so commonly developed in various parts of insects. The file is on the mesonotum and is a slightly raised oval area a little over a millimetre in length situated postero-dorsally with relation to the wing articulation. It has about 25 transverse ribs. When the wing is folded back in the normal position of rest a small lobe at the base of the hind margin of the fore-wing touches the lower edge of the file. An exactly similar stridulatory mechanism has been described by Jacobi (1907) in *Tettigades*, but he had never seen it in operation; he expressed the opinion that the noise was probably protective, since the file was equally developed in both sexes. The account of the behaviour given above shows that the stridulation is of sexual significance, just as is the wing-clicking in males and females of *Melampsalta* (Myers, 1929 : 209).

In living or freshly killed specimens of *Clidophleps* slow movements of the wings from the folded position cause grating sounds as the base of the wing scrapes on the file on the mesothorax. If the mesothorax is depressed and relaxed by pressure between the fingers, so that it moves in the same way as it would were the dorso-ventral thoracic muscles contracting, the wings perform a slow fluttering movement similar to the rapid fluttering in the field, and at the same time the stridulatory mechanism makes a grating noise. Presumably the wings will act as resonators; the loudness of the noise in the field is such that it can be heard from a distance of over a hundred yards. It is noteworthy that fluttering movements are described by Myers (1929 : 210–11) in both sexes of the cicada *Melampsalta* when excited by the presence of the other sex. Stridulation could therefore have been evolved in *Clidophleps* and *Tettigades* without any special change in habit.

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[1] The specimens were identified by means of the key in Van Duzee's paper (1915). The specific characters used in the genus *Clidophleps* are not very clear, size and colour being the main features used. The specimens seemed to be almost exactly intermediate in size of wings between typical *C. distanti* and *C. blaisdelli* (Uhler) while they agreed with *C. distanti* in the colour of the wing-veins, and with *C. blaisdelli* in the length of the body and the width of the mesonotum. *C. distanti* is divided by Van Duzee into a series of varieties, but he only collected specimens from San Diego county, and does not record either species from Riverside County, where my specimens were found. It seems best for the present to use the name *C. distanti* (Van D.) for these specimens, bearing in mind the possibility that they may really belong to a race different from any studied by Van Duzee.

Apparently the only previous account of the song of *Clidophleps* is that of Van Duzee (1915), who remarks that *C. distanti* shrills in unison, and produces a harsh rattling sound. It is probable that his description refers to the sound produced by the thoracic stridulatory mechanism, as the adjectives " harsh " and " rattling " apply much more accurately to this sound than to that produced by the timbals.

From the examination of a long series of cicadas in the British Museum this stridulatory apparatus appears to be confined to the Tibicenini, and to be best developed in *Tettigades*, some species of which have a very strong file with a few large teeth (Jacobi, 1907). It is also present in a number of other genera in the tribe. It is well developed in *Clidophleps blaisdelli*, just as in *C. distanti*. In the large genus *Okanagana* the condition is variable, but most species have the file fairly well formed, and it is well developed in *O. californica* Dist. and *O. vanduzeei* Dist.; it is absent in *O. occidentalis* (Walk.). It is well developed in *Tibicinoides cupreosparsa* (Uhler) and *T. hesperius* (Uhler), and in *Tibicina tomentosa* (Oliv.) and *T. quadrisignata* Fieb., but absent in *Tibicina septemdecim* (Linn.), *T. chinensis* Dist., and *T. crassimargo* (Spin.). It is also present in *Mendozana platypleura* Dist., *Chonosia crassipennis* (Walk.), *Okanagodes gracilis* Davis, *Paharia casyapae* (Dist.) and *Plautilla hammondi* Dist. It may well be present in some other genera and species, but it is certainly not present even in the majority of the Tibicenini in the British Museum collection. It remains to be seen what taxonomic value the presence or absence of this organ may possess.

Close by Deep Creek, where the Mohave River leaves the San Bernardino Mountains and flows out across the Mohave Desert, specimens of the small, almost wingless Acridiid Grasshopper *Oedaleonotus fuscipes* Scud. were found in small dead bushy plants a foot or so high. Attention was first drawn to them by the gentle clicking sound they made. There was no obvious movement of the body associated with the noise. Neither the legs nor the reduced tegmina made any movement at all. Eventually close scrutiny revealed a slight movement in the mouth-parts associated with the clicking noise, and it is assumed that the noise is made with the mandibles. The precise method of sound production is not understood, but from the nature of the sound, which is a click, not a squeak, no complex organ seems to be involved. Examination of the mandibles in a relaxed male specimen showed that they normally rest with the tip of the left overlapping the right. There were various teeth and projections on them, but they did not seem to be peculiar in any way. It was possible to catch the mandibles together if the right was closed slightly before the left. Perhaps the noise is made by letting the mandibles suddenly slip from this position to the normal position of rest. No such stridulatory mechanism is mentioned in Chopard's review (1938, chapter vii), and Dr. Uvarov told me that so far as he is aware this type of stridulation has not been described in any Acridiid. It is known that the soldiers of certain ants and termites, and the larvae of some Lepidoptera (*Acherontia atropos* (Linn.), *Saturnia pyri* Schiff.) click the mandibles together when irritated.

Oedaleonotus fuscipes has very well-developed auditory organs in both sexes. The tympani are shiny oval areas about 1 mm. across, and they are covered by the tegmina, which are themselves only 2 mm. long. (The length of the insect from the head to the end of the femur is about 20 mm.) The males and the females of *O. fuscipes* seemed to react to the clicking noise, and there is little doubt that this sound has the same significance for this species that the more specialised and louder types of stridulation have for other Orthoptera. It is noteworthy that *Oedaleonotus* belongs to the tribe Catantopini which, in the main, is made up of wingless species. Those species of *Melanoplus*, *Paroxya*, *Dendrotettix* &c. which are winged seem to lack any trace of stridulatory organs on the tegmina or the hind femora such as can be seen in the majority of winged male Acridiids. The fact that *Oedaleonotus fuscipes* has acquired an entirely new stridulatory mechanism is paralleled by the case of the Gryllid *Arachnocephalus* (Chopard, 1938 : 151) in which the wingless male attracts the female by making a small sound by tapping the abdomen on a leaf.

These insects, which belong to groups which normally use sound in courtship, have evolved new stridulatory mechanisms in addition to, or in place of, the normal mechanism in the group to which they belong. In this they resemble such birds as the snipe (*Gallinago gallinago* (L.)) and the greater spotted woodpecker (*Dryobates major* (L.)) in which "drumming" has partly taken the place of call notes produced by the syrinx.

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BOOK NOTICE.

The Principles of Insect Physiology. By V. B. WIGGLESWORTH. 8vo. London (Methuen). (1939.) pp. viii + 434, 316 figs. Price 30*s*.

In this book Dr. Wigglesworth has set out to produce a textbook of Entomology in which the emphasis is throughout on functions of the organs and tissues rather than on the form of insects. The author attempts to show that all the varied specialisations of insects are illustrations of the general principles of their physiology. Wherever possible physiology is related to ecology and is used to explain known behaviour under natural conditions. Descriptions of anatomy are reduced to the minimum needed to make the physiological argument intelligible. There are fifteen chapters : 1–3 deal with development and with the integument, 4–8 with locomotion and behaviour, 9–14 with assimilation, excretion and secretion, 15 with reproduction. Each chapter has a separate and extensive bibliography which is full and extremely up-to-date.

The work is the only one of its kind in the English language, and in view of its conciseness and the large amount of recent literature which is summarised it is assured of a warm welcome in all countries.

THE FRIGHTENING ATTITUDE OF TWO CALIFORNIAN MELOID BEETLES *PHODAGA ALTICEPS* LEC. AND *TEGRODERA EROSA* LEC.

By G. C. Varley, F.R.E.S.

The Meloid beetle *Phodaga alticeps* Lec. is a dull black insect (fig. 1), specimens of which were found in two places in the Californian deserts (Thousand Palms Canyon, Colorado desert; and near Baker, Mohave desert). Their black colour makes them very conspicuous as they walk rapidly over the pale sandy or gravelly ground in the bright sunshine. When one attempts to pick up one of these beetles it at once adopts a frightening attitude (fig. 2) by spreading both the elytra and the wings, and starts to walk in a jerky irregular way, without making any attempt to fly.

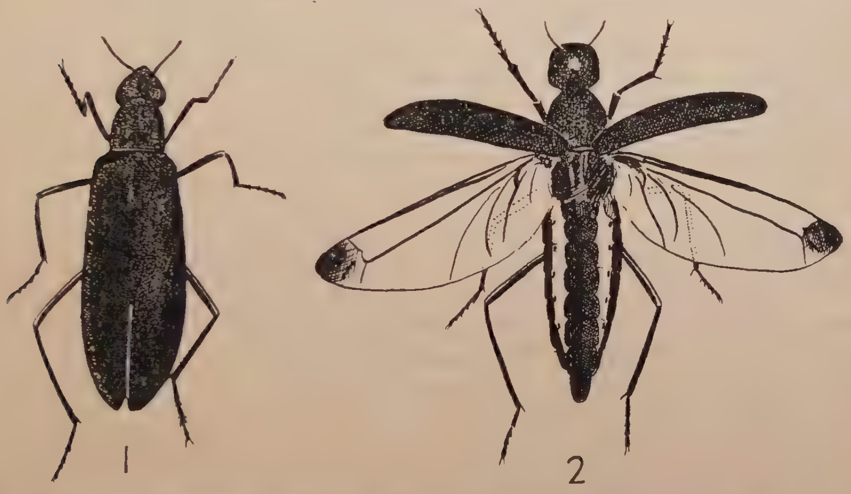

Fig. 1.—*Phodaga alticeps* Lec. in the normal attitude; fig. 2.—The same in the frightening attitude. (Both drawn from pinned specimens.)

The effect of this change of posture is very striking. It reveals two broad stripes of brilliant red along the sides of the abdomen, and the tips of the wings are black, and immediately catch one's attention. This behaviour has already been noted by Hubbard (1901), who found the species near the Gila river, in the desert part of Arizona. According to this observer there is a series of red scent glands on the abdomen which "it has the power of protruding or concealing at will, exactly as in the Malachiidae." However, he was unable to detect any strong odour. These glands were not seen by me in living specimens; nor has an examination of the abdomen of a female boiled in potash and inflated with air revealed any trace of them.

The related Meloid *Tegrodera erosa* Lec. was found in a small patch of ground close to the Citrus Experiment Station at Riverside, California. This species is rather larger than the last, and instead of being black, the head is

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bright chestnut-brown, and the elytra are yellow, marked with a reticulate pattern in black, giving rather the appearance of a peanut shell. In spite of these apparently bright colours the beetles were not very conspicuous as they walked about amongst the vegetation, or fed on the leaves and flowers of a blue *Gillia.* When irritated they strike a very similar posture to that of *Phodaga alticeps*, but they seem more reluctant to react than that species. Nor is the effect quite so startling because, though the red abdominal markings are very similar, the wing spot is less dark, and the insect is fairly brightly coloured in its normal attitude.

This peculiar attitude, which is a response to a threat or to irritation, seems not to be an attitude of defence or offence (though there is the possibility that scent glands may be brought into play). On the other hand, it has all the characters of a frightening or warning attitude. The change in posture suddenly exposes colours and markings which were out of sight, and entirely alters the shape of the animal and increases its apparent size. It is not known what predacious enemies attack these insects in their natural haunts, but in the regions where they were found there are many lizards and a few birds. Nor is it known whether the insects are distasteful. This can only be found out by experiment or detailed field observation. Since the species described here are fairly common in California, it would not be difficult to observe the reactions of captive lizards to their frightening attitudes. Successful experiments of this kind have already been made by Darlington (1938) on the acceptability of mimetic beetles.

I am indebted to Dr. K. G. Blair for the identification of these insects.

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COLOUR-PATTERN RESEMBLANCES BETWEEN WASPS AND OTHER INSECTS IN TRINIDAD

By Desmond VESEY-FITZGERALD, F.R.E.S.

So striking and minute in detail are the resemblances between certain entirely unrelated species of tropical wasps and other insects, and so obscure is any apparent need for this so-called mimicry, that a short contribution on the subject as exhibited by Trinidad species may be of interest. Colour-pattern resemblances, moreover, should not be divorced from behaviour, and it is only the field observer who is in a position to record the habits of the living insects and, in fact, is able to point out that two species, which may not appear similar in the dry state, are true " mimics " whilst alive.

For convenience of study the series to be considered may be arranged around the aggressive group of wasps belonging to the family POLYBIINAE. From this centre the " mimics " radiate outwards through related genera of VESPIDAE, including the subfamilies EUMENINAE, ZETHINAE, to the PSAMMOCHARIDAE, NYSSONIDAE and CHALCIDIDAE, and finally leaving the Hymenoptera, extend to include Coleoptera, Diptera and Lepidoptera. One after the other the counterparts of each particular species turns up, and it is tempting to suggest that a complete series for each combination of markings could be obtained by assiduous collecting.

Before considering the actual species observed it will be as well to touch on some general aspects of the subject. *Polybia* and related genera comprise wasps which form large nests inhabited by numerous individuals. The larger species are extremely aggressive and all are threatening in the defence of their home. If the colony is disturbed the wasps swarm out on to the envelope, often emitting an angry buzz and very little further provocation will lead to the intruder being fiercely attacked. Individually, however, these wasps will never attack, though of course they will sting if handled. In actual fact it seems possible that the sting is by no means a sure protection to the individual, since birds, frogs, Asilid flies and Attid spiders have all been found preying on Aculeate Hymenoptera. These facts, however, may be accepted as compatible with the general survival of the species; the colony is the important unit to protect; the individual worker has small value. Nevertheless it is the wasp as an individual and not the wasp as a component of a formidable colony that is " mimicked " by the insects under consideration.

Accepting these large colony-forming wasps as the " types," the " mimics " may be divided into two groups: (1) related insects and (2) unrelated insects. Related insects include other social wasps as well as other Hymenoptera. These are all more or less armed with stings and individually must be as well protected as the " types." Even with the social wasp " mimics," absolutely no attempt to imitate the colony is ever observed. It is always the individual, which seems to be " striving " for protection. The social wasp " mimics " are always species which form comparatively small colonies and so it may be taken that the individual in their case has nearly the same value as the individual of solitary wasps. In this group the details of mechanical resemblance are often minute, but behaviour resemblance, except in the circumstance of " mimic " and " type " being very closely related, is not so great. The unrelated insects which come into the series are essentially defenceless forms, and these, it may be presumed, gain some advantage from resembling a sting-bearing insect. In this case the mechanical resemblance is often rather poor, although the most remarkable modifications may be " attempted." The behaviour resemblance is, however, often very marked and subtle.

Gymnopolybia pallipes (Ol.) is a rather small yellow wasp forming large colonies inside hollow logs. This species is the starting-point for the most complete series of " mimics " which was collected. The closely related *Mischocyttarus surinamensis* (Sauss.) resembles in appearance *Gymnopolybia* down to the smallest detail. In fact even an entomologist examining a mixed series in a cabinet would not be able to sort out the two species without the aid of a hand lens. The prolongation of the posterior tarsal segments of *Mischocyttarus* is in fact the only marked difference. In flight the insects are indistinguishable, but much less detailed resemblance would achieve the same end. It has been noted that the *Gymnopolybia* lives in a hidden nest within a log. The little comb of *M. surinamensis* is exposed and the wasps are conspicuous on it. However, this type of nest can hardly be said, in the circumstances, to gain any protection by virtue of the fact that the *Gymnopolybia* is aggressive in the defence of its own colony. That no such protection is aimed at will become even more probable when other species of *Mischocyttarus* are considered.

The next insect in the series is a *Eumenes* sp. This solitary wasp exhibits only a very general resemblance to *Gymnopolybia*, but it is quite sufficient for the two to be momentarily confused in flight. The mud pots of the *Eumenes* cannot in any way benefit by the pattern of the wasp which builds them.

Two Psammocharids, provisionally determined as *Poecilopompilus polistoides* (Smith) and *P. mundiformis* come next in the series. The flight of the former is very like that of the POLYBIINAE, that is, it is characteristically from side to side rather than direct as is more usual in the case of PSAMMOCHARIDAE. For this reason the insect is rather easily confused with the " type " in flight. When settled, however, the dancing antennae and flickering wings at once proclaim the family to which the insect belongs.

An undetermined species of *Gorytes* which is of rare occurrence bears a very close resemblance to the *Gymnopolybia* both in flight and in the band.

The last in the series amongst the Hymenoptera is the Chalcidid *Polistomorpha* sp. In flight this insect is almost identical with the social wasp, but suspicion as to its true identity is aroused by the fact that the hind legs are held rather stiffly and not loosely trailing as is the case with the Vespid. At rest the Chalcid folds its wings longitudinally, which increases its resemblance to a Vespid.

The more distantly related " mimics " are the most interesting of the whole series. The Cerambycid beetle, *Odontocera fasciata* Oliv., apart from a general yellow coloration would hardly strike the systematic worker as being much like a wasp. The behaviour and habits of the beetle, however, bring the mimicry to perfection. The beetle breeds in dry logs of *Coccoloba* sp. and around these places large numbers of the beetles collect. On the wing the beetle flies with a quick dancing flight, the hind legs hang downwards and the abdomen is cocked upwards in a very wasp-like fashion. If any object attracts their attention, the beetles hover in front of it to make an inspection, or they settle and move about with quick jerky movements. Upon the slightest disturbance the beetles take flight in an instant. It is not surprising, therefore, that a party of these beetles round their breeding-place was actually mistaken for a colony of *Gymnopolybia* inside a dead log.

A Tipulid, which remains undetermined, proved an equally interesting addition to the series. This fly was only collected on two occasions but the behaviour was the same in both cases. In appearance the fly has the general colour but hardly the build of the wasp. In behaviour the mimicry is perfected in a most subtle way. When first observed the fly was flying to and fro, low over the ground, exactly like a wasp. After this had continued for a time the Tipulid settled in a moist spot and began dancing up and down on the tip of its abdomen. Probably this action was for the purpose of egg-laying, but it was typically the behaviour of a Tipulid and all resemblance to a wasp had gone. Upon a slight disturbance the fly, as if caught unawares, took flight and was immediately " transformed " into a wasp.

This series is completed by a Syntomid moth, but this insect has not been studied in life.

The remaining series are not nearly so complete as that following *Gymnopolybia*, but the insects which have been encountered may be mentioned.

Polybia rejecta (Fab.) and *Mischocyttarus injucundus* (Sauss.), *P. occidentalis* (Oliv.) and *M. punctatus* (Ducke), *Polybia* sp. and *M. fitzgeraldi* Beq. and *Parachartergus apicalis* var. *concolor* (Grib.) and *M. ater* var. *uniformis* Beq. are counterparts of each other, bearing resemblances in every way as perfect as that between *Gymnopolybia pallipes* (Oliv.) and *M. surinamensis* (Sauss.). The same general conclusions are also applicable to each of these pairs, but in addition it is worth mentioning that *M. fitzgeraldi* and *M. punctatus* have quite definitely made no use of the resemblance for the purpose of protecting their nest. In the case of the former the naked comb is inconspicuous and apparently designed to resemble a dry and curled-up leaf. When the nest is disturbed the wasps at once drop off as if dead and make no attempt to defend the nest. The extraordinary nest of *M. punctatus* is also extremely obscure and resembles a dry twig.

Polybia sycophanta Grib. and *Polistes pacificus* Fab. var., and *Polistes canadensis* (L.) and *Mischocyttarus labiatus* (Fab.) are also pairs in which a close resemblance may be noted. There is also a *Eumenes* sp. which has the same general markings as *Polybia occidentalis* and another *Eumenes* wasp which is a counterpart of *Synoeca surinamensis* (L.), while *Eumenes canaliculata* (Oliv.) has a very general resemblance to *Polistes canadensis* (L.).

A Psammocharid, *Batozonus fervidus* (Sm.), also bears a very close superficial resemblance to *Polistes canadensis*, but the flight and actions of the former are so characteristic of a Psammocharid that no confusion is ever likely to take place in the field.

The Syntomid moth, *Anycles affinis* Rothsch., bears a very close resemblance to *Parachartergus apicalis* (Fab.) and it is very interesting to note that both the wasp and the moth, which is day-flying, visit the same flowers.

These superficial resemblances are not confined to insects that are active during daylight. The nocturnal wasp *Apoica pallida* (Oliv.) is " mimicked " by a Conopid fly near the genus *Dalmannia*. The resemblance of the dead insects is not very close, but as the fly is attracted to light at night, with the wasps, the similarity between the living insects is most marked. Nothing is known about the habits of this fly, but it may well be associated with the wasp more intimately than by superficial resemblance.

BOOK NOTICE.

Die Verbreitung der Käfer Deutschlands. Tatsachen und Folgerungen. Von Dr. W. BORCHERT. 4to. Schönebeck (Elbe) (Im Selbstverlag des Verfassers). 1938. pp. 137 + 9, 47 maps. (Printed in three columns.)

This work is presented in four parts : Introduction, The facts, Conclusions, and Postcript. The second of these is in the main the essence of the book.

The arrangement of the work follows Winkler's Catalogue and the numerical references to that catalogue are given by each species. After the specific name is given in very abbreviated form the name of the " Pattern " map showing the distribution. The author has sorted the German beetles into series, each unit of which has a similar distribution, and this distribution is given on a map bearing the name of the typical representative. All beetles are referred to one or other of these 90 " Patterns," except in a few cases where it is not possible. This information is followed by more detailed information as to the actual distribution of the species. All the information given is very abbreviated in form. As is to be expected, many of the species dealt with have been recorded in Britain, and this is noted in the proper place. A useful feature of the work is the attempt to indicate the habitat and frequency of occurrence of the species.

The maps are outlines of Europe, with localities indicated by red lines and crosses.

OBSERVATIONS ON BEES (HYM.: APOIDEA) IN TRINIDAD, B.W.I.

By D. Vesey-FitzGerald, F.R.E.S.

The following notes and observations on bees of the families Xylocopidae and Anthophoridae were made during various periods of residence in Trinidad between the end of 1931 and 1935.

I am greatly indebted to Prof. T. D. A. Cockerell of the University of Colorado and to Dr. H. F. Schwarz of the American Museum of Natural History for determining the material. I have also to thank Dr. Weber of the University of North Dakota for the names of the ants, and Dr. Adamson, of the Imperial College of Tropical Agriculture, Trinidad, for the termite determination.

Xylocopa Latreille.

Xylocopa frontalis trinitatis Ckll.

Mt. St. Benedict, 15.i.35 (*Cassia bacillaris* L.); Guanapo Valley, 9.ii.35 (*Dioclea guianensis*); St. Augustine, 20.ii.35; Port of Spain, 18.viii.35; Toco, 19.v.35 (*Randia aculeata*); Maracas, Valley, 29.v.35; Port of Spain, 5.viii.35 (*Thunbergia* sp.); Maracas, 22.viii.35 (*Dipteryx odorata* Willd.).

This species has been found boring into dead wood on living trees of the following species:—*Theobroma cacao* L., *Haemadictyon* sp. (introduced tree) and " Bois mulattre."

A set of borings examined on 20.ii.35, was tenanted by two females and contained six cells, three with pupae, one with a larva and two empty. The single entrace was slightly oval, measuring 18 by 21 mm., and the tunnels were repeatedly branched, the cells being situated singly or in pairs in blind ends.

The cells averaged 23 mm. in length, the partition between each being of wood-chips about 6 mm. thick and neatly smoothed on the outside.

Xylocopa brasilianorum aeneipennis (Degeer).

Mayaro, 6.i.35 (*Mimosa casta* L.); Pt. Radix, 21.i.35 (*Cassia* sp.); Cumana, 18.v.35 (*Cordia* sp.); Toco, 19.v.35 (*Randia aculeata*); Mayaro, 15.vi.35 (*Eucalyptus* sp.).

This species has been taken nesting in a dead fallen log 42 mm. in diameter. The nest was examined on 6.i.35. The single entrance, 12 mm. diameter, led to a T shaped gallery 75 mm. long in one direction and 67 mm. long in the other direction. The longer arm contained three cells, each 20 mm. in length and separated by a 5·5-mm. thick plug of wood chips which was neatly smoothed on the outside. A larva was situated in each cell. The shorter gallery was not divided into cells; it was, however, complete because storing had started in its furthest extremity. A solitary female was attending the nest.

Xylocopa brasilianorum virescens Lep.

Mayaro, 6.xii.34, 6.i.35 (*Cajanus indicus* Spreg.); Mt. St. Benedict, 12.i.35 (*Gliricidia maculata* and *Cassia bacillaris* L.); Pt. Radix, 27.i.35 (*Cassia* sp.); Mayaro, 15.vi.35 (*Cassia* sp.).

Xylocopa barbata Fab.

Mayaro, 6.i.35 (*Solanum scabrum* V. and *S. stramonifolium* J.).

Xylocopa submordax Ckll.

Patos Is., 19.xi.33 (*Melochia tomentosa* (F. & R.), 11.xi.34 (*Tecoma stans*).

In 1933 the bee was extremely abundant on this island. Patos island, though politically belonging to Trinidad, is situated close to the coast of Venezuela.

Centris Fab.

Centris rufosuffusa Ckll.

Pt. Radix, Mayaro, 24.xi.34, 6.xii.34 (*Solanum* sp.); 30.xii.34, 6.i.35 (*Solanum scabrum* V.), 13.i.35, 3.xi.35.

This bee is known only from the type locality for the species. There is a large nesting colony at this spot, situated in the high sandy banks of a path cutting. It has a sharply restricted season of activity. No sign of the adults is seen until well into October, when a few males emerge and fly around the nesting holes in search of females. November and December are months of violent activity, the swarms of males accosting the females returning laden with pollen, especially in the morning, renders this particular pathway almost impassable. By January the numbers are rapidly waning and their season soon afterwards draws to a close.

The females excavated the burrows, and it is interesting to observe that those digging in the vertical bank are content to let the loosened sand tumble from the mouth of the burrow. Those digging in the horizontal path surface have to undertake more labour. The sand in this case is carefully pushed by the bee backwards for a distance of some six to eight inches from the entrance.

At the end of the tunnel the bee excavates a chamber for its cell. This chamber is lined with a wax-like substance, which is at first sufficiently moist to soak into and bind together the sand grains forming the walls of the chamber to the depth of 1 mm. Afterwards the whole hardens and the inner surface of the cell is smoothed. The cell is a cylinder, 19 mm. diameter and 32 mm. depth. The bottom is rounded. After being stored the cell is closed with a disc of the same waxy substance, in the centre of which is a curious knob-like process.

The Ant, *Sericomyrmex* sp., has been noticed robbing the store from unclosed cells.

Centris derasa Lep.

Northern Range, 1.i.35; Erin, 24.i.35 (*Solanum* sp.); Mt. St. Benedict, 7.ii.35 (*Byrsonima crassifolia* H.B.K.); Nariva, 10.iii.35; Maracas, 8.iv.35.

This bee has the curious habit of nesting in the living carton termitaria of *Microcerotermes arboreus* Emerson.

A nest tenanted by two females was examined on 1.i.35. From the entrance, diameter 13 mm., the tunnel was drilled horizontally into the carton. After a little way the tunnel made a right angle bend and continued downwards vertically. At the bottom of this shaft the four cells, 18 mm. diameter by 24 mm. deep, were situated one above the other.

To construct her cells the bee excavates a suitably large chamber and lines this with a wet wax-like substance which at first soaks into the walls and later drys, hardens and binds the whole cell into one piece.

This cell is half filled with the food-store, which is composed of " bee-bread " with a superficial layer of a clear sticky liquid. Upon this the single, curved, 6 mm. long, white egg floats. Finally the cell is closed by a plain disc of the waxy substance.

When the bees have vacated the cells the termites fill up the cells with carton and the whole becomes once more incorporated in the termitarium.

Hoplomutilla sp. is a frequent parasite of this species.

Centris flavifrons (Fab.)

Arena, 18.xii.31; Caroni, 2.xi.34; Mayaro, 18.iii.35 (*Gliricidia* sp.); Guayaguayare, 6.v.35.

The males are sometimes very abundant, flying around and resting on bushes.

Centris personata Sm.

Mayaro, 30.xii.34 (*Solanum scabrum* V.), 27.i.35.

Centris lineolata Lep.

St. Augustine, 20.x.31; Mayaro, 30.xii.34 (*Solanum scabrum* V.), 6.i.35 (*Cajanus indicus* Spreg.); St. Augustine, 22.iii.35 (*Elsota diversifolia* (L.).

Centris poecila Lep.

Erin Savannah, 23.i.35; Mt. St. Benedict, 7.ii.35, 8.ii.35 (*Elsota diversifolia* (L.)); St. Augustine, 22.iii.35 (*E. diversifolia*).

Centris bimaculata Lep.

Mt. St. Benedict, 7.ii.35 (*Elsota diversifolia* (L.)), 20.ii.35 (*Byrsonima crassifolia* H.B.K.).

Centris atriventris Mocs.

Trinity Hills, 29.xii.31.

The biology of this species has not been studied in detail, but it seems to have the curious habit of making its burrows in the nest mounds of the " parasol ants " (*Atta cephalotes* (L.)), situated on the floor of virgin rain forest.

Centris labrosa Friese.

Guaico, 12.iii.33; Maracas, 10.ix.35.

Centris minuta Mocsary.

Guaico, 12.iii.33.

Centris labrosa and *Centris minuta*.

These species appear to be associated in some way in their nesting habits, and in the following example it is not clear what is the exact rôle of each species, since three cells yielded two female *C. labrosa* and one male *C. minuta*. The bees were occupying old nests of the wasp, *Sceliphron* sp. Two or three of the bees' cells, 5 mm. diameter by 12 mm. long, were situated within one empty cell of the wasp. The latter had been lined with fragments of leaves. Within this lining was a comparatively thick wall of a wax-like substance in which was incorporated earth or possibly vegetable dust, and it was glazed on the inside. After the bee had completed and stored its cells, the original entrance to the wasp's cell was plugged with the same wax-like substance.

The two *C. labrosa* emerged on 6.iv.33 and 17.iv.33, respectively, one after a pupal period of three weeks. The *C. minuta* emerged on 11.iv.33.

Ptiloglossa Smith.

Ptiloglossa fulvo-pilosa Cameron.

Verdant Vale, Arima, 2.xii.34.

This bee is nocturnal and the late Mr. F. W. Urich supplied me with the following interesting note :—" The bees may be heard buzzing round certain flowering trees during the night but directly the first light of dawn shows over the horizon they, with one accord, return to their burrows and are not seen again all day."

The only colony examined was situated in the earth under a raised house near Arima. The burrows descended vertically for some eight inches and then turned at right angles and continued for a further few inches in a horizontal direction. This site has been occupied by the bees during a period of ten years.

Epicharis Klug.

Epicharis rustica flava Ckll.

Arima Valley, 1.xi.31, 6.xi.34, 7.iv.35 (*Solanum* sp.); Mayaro, 30.xii.34 (*Solanum scabrum* V.), 6.i.35; Mt. St. Benedict, 7.ii.35 (*Byrsonima crassifolia* H.B.K.).

The only colony of this bee that was examined was in rather an extraordinary situation. The bees were occupying the tunnel of an abandoned gold working, a site which they shared with many bats of the species *Hemiderma brevicauda* Wied. and *Desmodus rufus* Wied. The burrows of the bee were situated in the walls of the working at some twenty yards from the entrance, which was about the limit of penetration of daylight.

At the end of the burrow the walls of a chamber were " glazed " but there was no penetration of waxy substance into earth walls, so no solid cell could be dug out as is usually the case with *Centris*.

Females were found actively storing their cells during the month of November 1931 and 1934.

Epicharis lateralis Sm.

Tucuche, 3000 ft., 15.xii.34 (*Byrsonima trinitatis* (Juss.)). This bee was noticed to visit flowers before dawn.

Epicharis quadrinotata Mocsary.

Guayaguayare, 22.xii.34; Mayaro, 6.1.35 (*Solanum scabrum* V.).

Epicharis fasciata trinitatis Ckll.

Maracas Bay Rd. 1.x.33.

The only colony examined was situated in an earth bank beside a road. The " cells " cannot be removed from the burrows without breaking. The colony was just commencing activity at the beginning of October, when many males were flying round the banks.

This species is parasitised by the Melectid, *Rhathymus trinitatis* Ckll. and the Meloid, *Tetronyx pectoralis* Mg. (*det.* K. G. Blair).

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>
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TO BE HELD IN THE SOCIETY'S ROOMS

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1939.

WEDNESDAY,	October	4	6.0 p.m.	
"	"	18	8.0 p.m.	
"	November	1	6.0 p.m.	
"	"	15	8.0 p.m.	
"	December	6	6.0 p.m.	

1940.

WEDNESDAY,	January	17	8.0 p.m.	(ANNUAL MEETING)
"	February	7	6.0 p.m.	

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